Exemption No. 7790

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of **The Boeing Company** for an exemption from § 25.961(a)(5) of Title 14, Code of Federal Regulations	**Regulatory Docket No. FAA-2001-11155**

GRANT OF EXEMPTION

By letter dated November 8, 2001 (B-H320-2001-00899), Mr. Edgars A. Kupcis, Manager, Certification, Certification & ETOPS Programs, B-H320, The Boeing Company, P.O. Box 3707, Seattle, WA 98124-2207, petitioned for an exemption from the requirements of § 25.961(a)(5) at Amendment 25-85 of Title 14, Code of Federal Regulations (14 CFR) to permit The Boeing Company, for the Model 757-300 series airplanes powered by Pratt & Whitney PW2000 series engines, to be relieved of the requirement that the airplane and engines perform satisfactorily with the critical fuel at a temperature of at least 110°F.

Sections of the Federal Aviation Regulations (FAR) Affected

> Section 25.961(a)(5), at Amendment 25-85, requires that the airplane and engines perform satisfactorily with the critical fuel at a temperature of at least 110°F.

Petitioner's Supportive Information

The Boeing Company's supportive information is summarized as follows:

> Boeing is introducing a Model 757-300 series airplane powered by Pratt & Whitney engines. The Model 757-200 series airplane with Pratt & Whitney engines was introduced in 1984, and has accumulated over 11.6 million flight hours of revenue service. The Model 757-300 series airplane with Rolls Royce engines was introduced in 1999 and has accumulated over 80,000 flight hours of revenue service. The Pratt & Whitney-powered

Model 757-300 series airplane will offer three engines: PW2037, PW2040, and PW2043. The Model 757-200 series airplane offers PW2037 and PW2040 engines.

Boeing is requesting relief from the requirements of 14 CFR 25.961(a)(5), at Amendment 25-85, for the Pratt & Whitney-powered Model 757-300 series airplane. The regulation requires that the airplane and engines perform satisfactorily with the critical fuel at a temperature of at least 110°F. Boeing requests that the FAA approve a set of limitations for JP-4 (a military designation for a Jet B type commercial grade fuel with additives) and Jet B fuels on the Pratt & Whitney-powered Model 757-300 series airplane in lieu of compliance with the specified temperature of 110°F. The limitations consist of restricting the fuel temperature to 85°F, restricting the initial cruise altitude vs. fuel temperature, and restricting JP-4 and Jet B fuels to the main tanks only. These same limitations were approved for the Rolls Royce-powered Model 757-300 series airplane.

Boeing submits this petition for the following reasons:

(1) It is in the public interest. Airline operators strongly desire the operational flexibility of JP-4 and Jet B fuels, and a maximum temperature of 85°F meets their needs.

(2) The Model 757-200 series airplane with Pratt & Whitney PW2037 engines demonstrated satisfactory performance with JP-4 at 104°F. All Pratt & Whitney-powered Model 757-200 series airplanes are approved for JP-4 and Jet B use up to 110°F.

(3) There will be no significant differences in the fuel system between the Pratt & Whitney-powered Model 757-200 and the Model 757-300 series airplanes.

(4) The proposed limitations on fuel temperature, maximum altitude for initial cruise, and prohibition on the use of JP-4 and Jet B fuels in the center tank provide a level of safety equal to that intended by 14 CFR 25.961(a)(5).

(5) The FAA granted a similar exemption for the Rolls Royce-powered Model 757-300 series airplane (FAA Exemption No. 6867, issued Feb. 12, 1999, Regulatory Docket No. 29202). The Rolls Royce-powered Model 757-200 series airplane has had an 85°F temperature limitation for JP-4 and Jet B fuels since entry into service in 1983.

Public Interest

Boeing argues that it is in the public interest that airlines be able to operate with JP-4 and Jet B fuels. These fuels are used in some parts of the world and are occasionally the only fuels available at military airfields that may serve as diversion airports. The economic impact of not being able to divert to these airfields in the event of an emergency is significant. When surveyed, several 757 operators reported that the loss of this capability would significantly impact their operations. Excerpts from two operators are provided below.

> *The usage of JP-4 fuel is very rare, but in a few occasions it was necessary… due to diversions to military airfields. Restricting the use of JP-4 fuel would heavily impact the*

operation … as several enroute alternates or destination alternates could no longer be chosen for flight planning. This is especially true for the areas of Alaska, Canada, Caribbean, Iran/Persia and Turkey.

If the aircraft were not certificated to use JP-4/Jet B then each sector would need to be re-evaluated with respect to approved diversionary airfields and reserve fuel carried, so it is quite possible that there would be many routes which would cost more to operate and others where a decision would be made not to operate because of the capability of the aircraft.

Boeing contends that the economic impact of full compliance with 14 CFR 25.961(a)(5) would be debilitating. It is unlikely that the existing Pratt & Whitney- and Rolls Royce-powered Model 757's or the upcoming Pratt & Whitney-powered Model 757-300 series airplanes would satisfy the performance requirements as they have been applied to recent new airplane programs with 110°F fuel. A major redesign to the airplane fuel feed system, fuel tanks, and potentially the airplane electrical system would be required to satisfy these requirements as most recently interpreted. These changes would involve an expensive re-certification effort of the Model 757 fuel feed system with essentially no return on investment or enhancement of safety. It is probable these changes would introduce new failure modes into the present system that has proven very reliable in service.

Level of Safety Provided

With regard to 14 CFR 25.961(a)(5), the ability of an airplane to operate with JP-4 and Jet B fuels is a function of the vapor pressure of the fuel, which increases with temperature. The vapor pressure of wide cut fuels such as JP-4 and Jet B is considerably higher than that of narrow cut fuels such as Jet A. Under normal conditions, the aircraft fuel boost pumps maintain the pressure in the fuel feed system above the vapor pressure of the fuel.

If all aircraft boost pumps are inoperative, the engine fuel pumps will continue to draw fuel out of the tanks to maintain engine operation. This is termed suction feed operation. At high fuel temperatures and high altitudes, the pressure in the fuel feed system can decrease to or reach a value near the vapor pressure of the fuel, allowing some fuel to vaporize and potentially causing engine flameout. Regulation 14 CFR 25.961(a)(5) addresses this condition, among others, and is intended to ensure that airplane operation will not be adversely impacted by fuel temperature.

Boeing believes that incorporating a temperature limitation of 85°F for JP-4 and Jet B fuels provides a level of safety equal to that intended by the regulation. This position is based on several considerations:

a) Differences between the Model 757-200 and Model 757-300 series airplane fuel systems do not affect suction feed operation. The changes include longer wiring between the fuel quantity indicating system processor and in-tank capacitance probes,

a slightly increased allowable fuel volume for all three fuel tanks, and a longer fuel feed hose to the auxiliary power unit. These changes were certified on the Rolls Royce-powered Model 757-300 series airplane. There are no further airplane fuel system changes planned for the Pratt & Whitney-powered Model 757-300 series airplane.

b) There are no hardware differences between the PW2037/PW2040 engine fuel systems on the Model 757-200 and Model 757-300 series airplanes.

c) Hardware differences between the PW2037/2040 and PW2043 engine fuel systems do not adversely affect suction feed operation. There are two changes in the engine fuel system to support the PW2043: the fuel control unit (FCU) and the fuel pump. The PW2043 FCU is the same basic unit as the PW2037/2040 FCU with a larger fuel-metering window. The PW2043 fuel pump is designed to match the performance of the PW2037/2040 pump with increased flow capacity at higher pump rotational speeds. The PW2043 pump was certified for use on the Model 757-200/PW2037 and PW2040 via bench and flight testing in June 2000. Suction feed requirements were substantiated by back-to-back rig testing.

d) Thrust differences at maximum continuous thrust (MCT) between the PW2037, PW2040, and PW2043 are offset by the temperature limitation of 85°F. The Model 757-200 series airplane with PW2037 engines demonstrated satisfactory performance in suction feed operation with JP-4 fuel at a temperature of 104°F. The slightly lower system pressure resulting from the increased fuel flow at PW2040 and PW2043 thrust is more than offset by the decreased vapor pressure between 104°F and 85°F. The slightly higher fuel pump rotor speed at PW2040 and PW2043 thrust has a negligible effect on the net positive suction pressure required by the pump to prevent cavitation.

In addition to the temperature limitation, Boeing proposes to incorporate additional restrictions on altitude vs. temperature and center tank usage to further ensure an equal level of safety. The following limitations, already approved and incorporated in the Rolls Royce-powered Model 757-300 airplane flight manual, are proposed for the Pratt & Whitney-powered Model 757-300 airplane flight manual:

(1) JP-4 or Jet B fuel shall not be used in the center tank.

(2) The maximum allowable fuel temperature for JP-4 or Jet B fuel is 85°F.

(3) When operating with JP-4 or Jet B fuels, the maximum allowable altitude for the first two hours of cruise operation shall be limited to:

Dispatch Fuel Temperature (°F)	Altitude Limit (Feet)
65 to 85	32,000
45 to 65	36,000
25 to 45	39,000

15 to 25	41,000
15 or Lower	42,000

(4) The fuel tanks must be defueled to sump level (i.e. level at which fuel pump low-pressure lights illuminate) following operations with JP-4 or Jet B fuel. If the fuel tanks are not defueled, the JP-4 fuel usage limitations shall continue to apply.

It should be noted that there is an inherent margin of safety associated with limiting JP-4 or Jet B fuel usage based on suction fuel feed capability. Under normal conditions, the airplane fuel boost pumps will be functioning. There are two alternating current (AC) powered boost pumps in each of the main fuel tanks, and two AC-powered boost pumps in the center fuel tank. The center tank boost pumps can adequately supply fuel to the engines with the main tank boost pumps inoperative. Under pressure feed conditions, the airplane can operate normally with JP-4 fuel at a temperature of 110°F up to maximum altitude. Suction feed operation is required only when all AC power is lost on the airplane. The probability of this occurrence is extremely low due to redundancies incorporated in the airplane electrical system.

Notice and Public Procedure Provided

On March 28, 2002, the FAA published notice of the petition for exemption in the Federal Register and requested comments from the public. No comments have been received.

FAA's Analysis of the Petition

The regulation regarding fuel system performance with hot fuel is intended to ensure that an uninterrupted fuel supply is provided to the engines. Section 25.961(a)(5) specifically requires that this capability be demonstrated with fuel at a temperature of at least 110 °F. The Boeing Model 757-200 series airplane with Pratt & Whitney PW2037 engines was shown by testing of components and fuel system analysis to directly comply with § 25.961(a)(5). As discussed by the applicant, an 85 °F. fuel temperature limitation was imposed for Boeing Model 757-200 series airplanes equipped with Rolls-Royce engines following testing intended to show compliance with § 25.1351(d). This testing showed that engine power interruption could not be induced at any altitude within the airplane performance envelope with JP-4 fuel at a temperature of 85° F. A similar, early test on the 757-200 airplane with Pratt & Whitney PW2037 engines demonstrated adequate performance of the fuel system with 104° F. JP-4 fuel and JP-4/Jet B use was therefore unrestricted within the normal 110° F. limitation.

Since the original finding of compliance with § 25.961(a)(5) on the Boeing Model 757-200 series airplane with Pratt & Whitney PW2037 engines, the FAA has determined that a more extensive flight test of the airplane with hot fuel is necessary to show compliance with this section. Analysis and component testing alone are no longer accepted by the FAA as an adequate demonstration of compliance because of unexpected

fuel flow interruption to the engines during certification flight testing on an airplane utilizing these methods. However, in this petition for exemption, the applicant has proposed operational limitations on dispatch fuel temperatures and altitude that ensure that satisfactory fuel system performance will be achieved. These limitations are consistent with flight test performance previously demonstrated by the airplane and engines, and with the latest, more stringent, requirements.

The petitioner has requested that the Boeing Model 757-300 derivative airplane equipped with Pratt & Whitney PW2000 series engines be granted an exemption from § 25.961(a)(5). The information provided by the petitioner indicates that granting of the exemption to allow use of JP-4 and Jet B fuel would be in the public interest because it will allow use of alternate airports where these fuels are the only fuels available. Public safety would not be adversely affected because the temperature and fuel loading limitations placed on the airplane will limit operation of the airplane to fuel temperatures where satisfactory fuel system performance has been demonstrated.

The Grant of Exemption

In consideration of the foregoing, I find that a grant of exemption is in the public interest and will not adversely affect the level of safety provided by the regulations. Therefore, pursuant to the authority contained in 49 U.S.C. 40113 and 44701, delegated to me by the Administrator, the petition of the Boeing Company for an exemption from the fuel system hot weather operation requirements of § 25.961(a)(5) at Amendment 25-85, for the fuel system of the Boeing Model 757-300 series airplanes powered by Pratt & Whitney PW2000 series engines, is hereby granted, with the following limitations.

The following limitations are to be included in the airplane flight manual (AFM) for Model 757-300 series airplanes powered with Pratt & Whitney PW2000 series engines:

"Operational Limits:

"(1) JP-4 or Jet B fuel shall not be used in the center tank.

"(2) The maximum allowable fuel temperature for JP-4 or Jet B fuel is 85°F.

"(3) When operating with JP-4 or Jet B fuels, the maximum allowable altitude for the first two hours of cruise operation shall be limited to:

Dispatch Fuel Temperature (°F)	Altitude Limit (Feet)
65 to 85	32,000
45 to 65	36,000
25 to 45	39,000
15 to 25	41,000
15 or Lower	42,000

"(4) The fuel tanks must be defueled to sump level (i.e. level at which fuel pump low-pressure lights illuminate) following operations with JP-4 or Jet B fuel. If the fuel tanks are not defueled, the JP-4 fuel usage limitations shall continue to apply."

Issued in Renton, Washington, on June 3, 2002. .

/s/Ali Bahrami

Ali Bahrami
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Aircraft Certification Service